A GUIDE FOR SHEEP AND FARM LIFE

THE SHEPHERD

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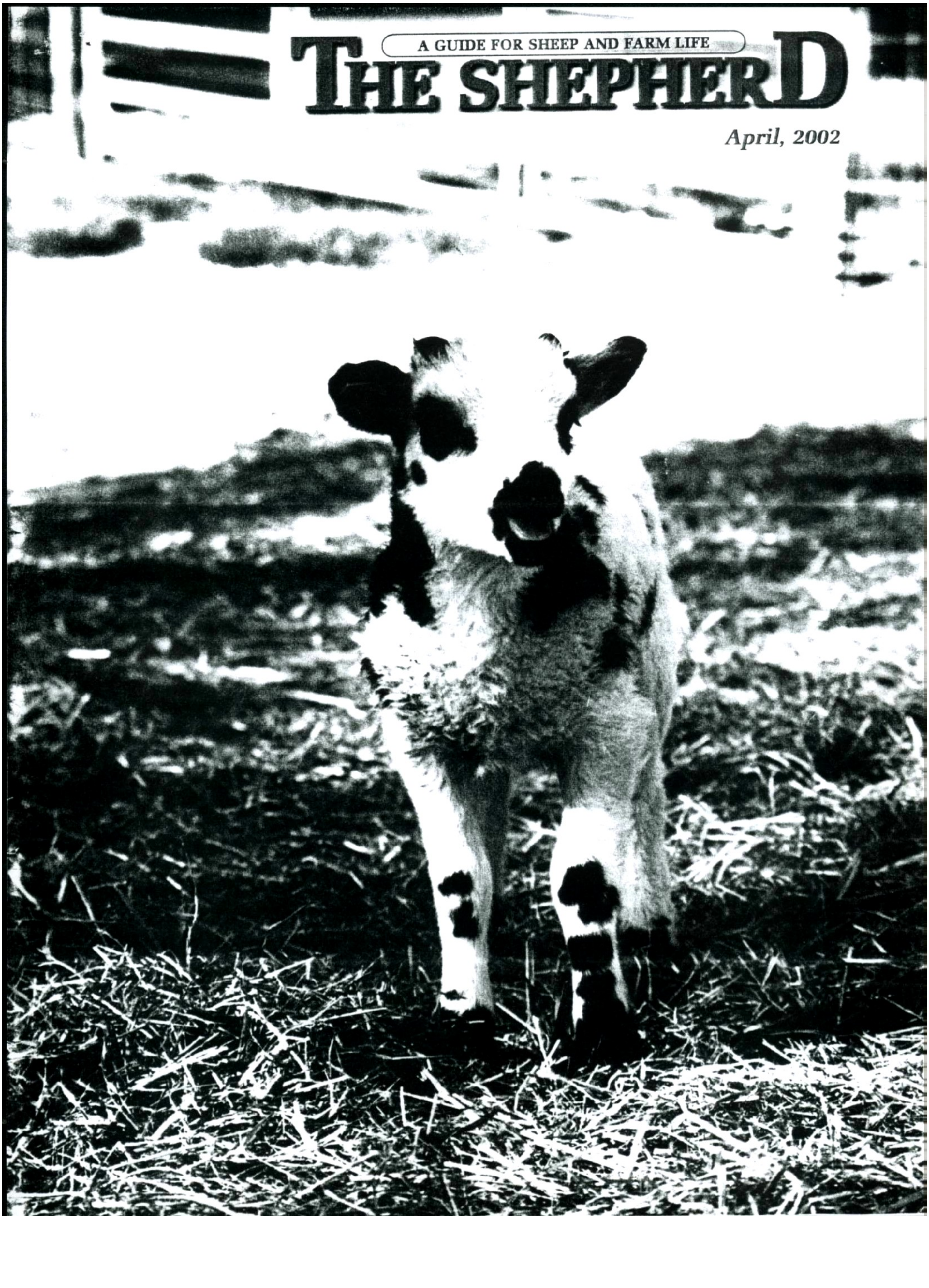

Effect of Growth Rate on Udder Development in the Prepubertal Ewe Lamb: A Review

SUMMARY

Many commercial sheep producers, including dairy sheep producers, raise their replacement ewe lambs with their market lambs, feeding high-energy diets for the purpose of reaching early market weight. Producers thus generally assume that maximal growth rate in their ewe lambs, just as for their market lambs, is desirable. However, a large amount of research now indicates that, prior to puberty, rapid daily gain in replacement females can significantly reduce udder growth. Reduced udder growth prior to puberty in dairy females (as a result of high growth rate prior to puberty) can result in 10 to 17% less daily milk production during the 1st, 2nd, and 3rd lactation compared to animals that grow at slower growth rates. Conversely, animals that grow too slowly reach puberty at a later age, which can decrease lifetime reproductive performance. Therefore, it is paramount that more attention be given to determining the proper growth rate in dairy ewe lambs. Specifically, growth rates must not be too high, resulting in lower milk production, nor must growth rate be too low, resulting in lower reproductive efficiency.

The reason for the marked effect of nutrition on mammary growth in dairy ruminants prior to puberty is due in part to the inverse relationship between growth hormone (GH) concentration and feeding level. When animals are fed at lower levels of energy, GH release and concentration is relatively higher, compared to when animals are fed "free-choice." Growth hormone stimulates cell replication and division, and also acts via other hormones to make energy more available to the mammary gland, thus favoring proliferation and growth of the tissues that will eventually be responsible for milk secretion.

The other important component in prepubertal mammary growth is the contribution of the fat pad. The fat pad provides not only the framework for mammary growth, but is also a source of local hormones necessary for the growing mammary gland. If nutrition is restricted, and the fat pad too small, mammary growth can also be inhibited because the expanding system of ducts (eventually responsible for the transport of milk in the mammary gland) will not have sufficient space for growth.

Although there are relatively few reports on target growth rates in ewe lambs prior to puberty, if one extrapolates from the dairy heifer, it would appear that a daily gain of 65 to 75% of maximum would be desirable for ewe lambs. The objective of this paper is to review the available research concerning the effect of nutrition on mammary growth in the replacement ewe lamb, and the subsequent impact on lactation performance.

UDDER DEVELOPMENT PRIOR TO PUBERTY

- **The tissues in the mammary gland can be divided into two general types and are referred to as the *parenchyma* and the *stroma*. The parenchyma refers to the special cells that secrete milk and to the ducts which transport milk. The stroma refers to the surrounding tissue (fat pad) that supports the parenchyma, which also contains the connective tissue, blood vessels, nerves, and special contracting cells which push milk through the ducts.**

As the mammary gland develops prior to puberty, there is growth and expansion of the network of milk ducts throughout the fat pad. During pregnancy, the cells of the expanding ducts (epithelial cells) will further proliferate and differentiate into either more ducts or into the specialized milk-producing cells, collectively arranged within a structure called the alveoli. The alveoli are localized in the upper portions of the mammary gland and thus become the true site of milk synthesis during lactation.

In our domestic dairy ruminants, females are born with the basic structures of the mammary gland already put in place. The teats are visible, and each one is internally connected to a single primary duct. Between birth and puberty, the mammary gland will go through two important growth phases: the first is known as ***isometric growth***, where the mammary gland grows at the same rate as the rest of the body. Isometric growth occurs until 2 to 3 months in the calf, and probably until 1 to 2 months in the lamb. During the isometric phase, the development of the mammary gland is limited to growth of the secondary ducts that will ultimately connect the cistern and the alveoli during lactation, and to growth of the stroma (Sejrsen and Purup, 1997). The second important growth phase is known as ***allometric growth*** when the mammary gland actually grows proportionally faster than the rest of the body. In ewe lambs this begins during the second month of life. During allometric growth the epithelial cells within the udder are dividing and proliferating very quickly (see Figure 1) and the fat pad is also growing, adding adipose tissue and the structurally-supporting connective tissues to the udder (Sejrsen et al., 2000). After puberty, the mammary gland reverts back to isometric growth, with growth again paralleling that of the whole body.

Pregnancy causes the mammary gland to undergo another period of extensive development and allometric growth (Sejrsen et al., 2000). In the ewe, mammary growth in early pregnancy consists of rapid growth of the ducts. In late pregnancy, epithelial cells form the alveoli, which are anchored to the stroma. DNA analysis of cell numbers of epithelial and connective tissue in Romney sheep showed that 20% of gland growth occurred between birth and puberty, 78% during pregnancy, and 2% during lactation (Anderson, 1975).

Total milk yield is proportional to total epithelial cell numbers (Hovey et al., 1999). As revealed by the Romney ewe study above, 98% of epithelial cell numbers are established by the time the ewe will give birth. Between lambing and peak lactation, the cells that secrete milk increase in size and become more fully differentiated. Forsyth (1995) studied the relationship between milk yield and alveolar cell activity and lactation persistency in dairy cattle. She found that after peak lactation, activity per individual cell is maintained, and that alveolar cell loss is the primary cause of milk yield decline. In the modern dairy cow, peak yield accounts for 66 to 80% of the variation in total yield, and lactation persistency (days in milk) accounts for only 8 to 12 % of the variation. In other words, peak yield is primarily determined by the number of cells secreting milk. Therefore, any process that negatively impacts epithelial cell numbers will negatively impact total milk yield.